Attachment A

CAP ANALYSIS

# DO UNE RATES REFLECT UNDERLYING COSTS?

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## I. Introduction

The regulatory regime under which incumbent telephone companies are required to offer portions of their networks to competitors is a joint product of Federal and state authorities. While the regime is extremely complex, it can broadly be described as having two main substantive components: 1) Regulations setting out which elements of the incumbents' networks must be offered (or "unbundled"); and 2) Regulations that set the prices that must be charged for those elements. Under the Telecommunications Act ("the Act"), as implemented, authority for both components of the regulatory regime is shared between the Federal Communications Commission (FCC) and the states, generally acting through state Public Utility Commissions (PUCs).

While the precise division of authority between the FCC and the PUCs is a source of substantial controversy and ongoing litigation, there is general agreement that the policy of mandated access to incumbent networks should be implemented on a nationally consistent basis – i.e., that, regardless of the level at which decisions are made, they should be made on the basis of, and comport with, a single analytical framework. Broadly speaking, it is the FCC's responsibility to establish the framework, and the PUCs' responsibility to implement it.

In this study, we examine state PUCs' implementation of the FCC's rules regarding the pricing of "Unbundled Network Elements" (UNEs), i.e., the portions of the network which the FCC requires be made available to competitors. Specifically, we utilize regression analysis and other statistical techniques to assess the extent to which the UNE prices set by the states are systematically related to costs, a procedure which, as we explain below, is essentially a generalized form of the FCC's "benchmark test"for determining the consistency of rates across states. We find that variations in costs among the states explain only about half of the variation in the rates set by state PUCs. Furthermore, the typical deviation of state-set rates from costs is at least 15% from the levels that would be implied by a systematic approach. These results suggest that the current regime has not resulted in consistent application of the FCC's regulatory framework.[1]

The remainder of this paper is organized into five sections. First, we briefly describe the FCC rules governing the setting of UNE rates by the states. Next, we discuss the data we use to estimate variations in state rates relative to costs. Third, we explain our regression model. The fourth and fifth sections, respectively, present our results and offer a brief summary of our findings, including their economic implications.

## II. The TELRIC Rules

Section 252(d)(1) of the Act provides that UNE rates must be "based on the cost (determined without reference to a rate-of-return or other rate-based proceeding) of providing the interconnection or network element...." Pursuant to this provision, the FCC in 1996 issued rules mandating that states apply a particular model to ascertain such costs. Known as "TELRIC," (for "Total Element Long-Run Incremental Cost"), the model is intended to ensure a consistent framework for the rate-setting activities of the PUCs. In issuing the original rules, the Commission found that a national framework would "reduce or eliminate inconsistent state regulatory requirements, increase the predictability of rates, and facilitate negotiation, arbitration and review of agreements between incumbent LECs and competitive providers."[2] The TELRIC model was the subject of extended litigation, and the FCC's national rules ultimately were upheld by the Supreme Court.[3]

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[1] Our results are thus consistent with, and provide statistical validation for, the conclusions reached by economists Kenneth Arrow, Gary Becker, Dennis Carlton, and Robert Solow in a recently released paper. While they did not conduct a detailed analysis of rates and costs, as we do here, their examination of variation in UNE rates across states and over time led them to conclude that "TELRIC prices must be set incorrectly in at least some states, given the wide variation in rates across states and the large, abrupt changes in rates in some states." See "Report of Kenneth Arrow, Gary Becker, Dennis Carlton, and Robert Solow on Behalf of Verizon" (undated), pp. 15-18.

[2] *Implementation of the Local Competition Provisions of the Telecommunications Act of 1996*, CC Docket No. 96-98, First Report and Order, ¶105. See generally ¶¶ 104-120. Available at http://ftp.fcc.gov/Bureaus/Common_Carrier/Orders/1996/fcc96325.pdf. (Hereafter "TELRIC Rules.")

[3] *Verizon v. FCC*, 535 U.S. at 497-529.

On September 10, 2003, the FCC adopted a Notice of Proposed Rulemaking under which it is reviewing the 1996 rules and considering revisions. One of the main issues before the Commission in its review is the extent to which states have implemented the TELRIC rules in a consistent fashion. The NPRM notes that "State pricing proceedings under the TELRIC regime have been extremely complicated and often last for two or three years at a time. State commissions typically are presented with at least two conflicting cost models, and hundreds of inputs to those models, all supported by testimony of expert witnesses. These cases are extremely complex, as state commissions must make dozens of detailed decisions regarding the calculation of forward-looking cost of building a local telecommunications network.... Part of the difficulty that states and interested parties have encountered stems from the excessively hypothetical nature of the TELRIC inquiry."[4] As a result, the NPRM specifically notes that "in a number of cases, the Commission found that various aspects of state pricing decisions appeared to be inconsistent with the forward-looking cost principles on which our rules are based."[5] Many of the changes proposed in the NPRM are designed, at least in part, to lead to more consistent results.[6]

## III. TELRIC Prices vs. Underlying Costs: Data Issues

In practice, states set rates for each major element of the network that is required to be made available – that is, for each UNE. For each element, states are required to set TELRIC rates based on forward-looking costs. Thus, only two sets of data are required to assess the degree of cross-state consistency: The rates set by the states, under TELRIC, for each UNE, and the (forward-looking) costs for each UNE. In

[4] *Review of the Commission's Rules Regarding the Pricing of Unbundled Network Elements and the Resale of Service by Incumbent Local Exchange Carriers,* WC Docket No. 01-173, September 10, 2003, ¶6-7. Available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-03-224A1.doc. (Hereafter "TELRIC NPRM.")

[5] TELRIC NPRM, ¶12.

[6] The TELRIC NPRM requests comments on possible changes relating to key elements of the TELRIC model, including Network Assumptions, Cost of Capital, Depreciation Expense, Expense Factors, Non-recurring Costs, Rate Structure, Rate Deaveraging and Rate Changes Over Time.

this study, we rely on data from two sources: a survey of actual UNE *rates* compiled by the National Regulatory Research Institute (NRRI), and an FCC model of forward-looking *costs* developed for the purpose of calculating universal service support. In this section, we describe the two data sources and explain why they are appropriate for our analysis.

*Rates:* Data on UNE rates are compiled semiannually by the NRRI.[7] For each of 48 states and the District of Columbia, NRRI determines a state average rate for the most important UNEs: loops, line ports, switching, and tandem switching.[8] The most consistent data over time are reported for loops and ports, where data is available for April 2001 through July 2003. NRRI also reports rates for UNE-Ps – i.e., a bundled set of UNEs often purchased by non-incumbent carriers in order to minimize or avoid altogether the need to make significant investments in their own infrastructure. NRRI calculates UNE-P rates as the sum of loop costs, port costs, and the costs of 1000 minutes of switch use per month.[9] Our analysis focuses on the most recently available data, from July 2003. Also, because NRRI's loop rate data appears to be more reliably reported than its data on UNE-P,[10] we focus our analysis on variation in the loop rates.[11]

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[7] The most recent data is available at www.nrri.org; data for all years is available at http://www.cad.state.wv.us/Une Page.htm.

[8] NRRI reports rates but not state-average rates for Alaska and Hawaii.

[9] See the description of the July 2003 rate study at http://www.cad.state.wv.us/July 2003 Intro to Matrix.htm. Note that this data applies only to the wirecenters of the major RBOC in each state, and does not capture variation associated with other LECs, including small, rural LECs. We would expect the inclusion of data for the smaller LECs to increase the reported variation, as these companies tend to serve atypical (i.e., high-cost) areas.

[10] For example, in some instances, the NRRI reports a weighted average of the loop rates for different line density groups as the state average loop rate, but calculates only a simple average of the switching rates for those groups. In other instances, the UNE-P rate reported in the appendix of the rate surveys for several years does not match one calculated by the formula; we use the rate reported in the appendix. Also, reported average UNE-P rates depend on an assumption for switch use, whereas in practice such use may vary across states.

[11] We also report results for UNE-P, however. The results are not substantially different than our results for loops. Note that for a handful of states NRRI reports UNE combination rates, where the loop and/or the port rate is lowered, that apply to a loop-port combination or a UNE-P rate. Our analysis applies these combination rates to our UNE-P rate calculations but not to our loop rate calculations.

One should keep in mind that these rates are state averages. Thus, these rates are not necessarily representative of the rates holding for any specific UNE at any particular location. As we are concerned with the outcomes of decisions made at the state level, however, these data are appropriate for our analysis.

*Costs:* While actual rates are observable, forward-looking costs, by their very nature, are not.[12] Accordingly, we use a proxy measure: The average forward-looking costs for each UNE element in each state as of 2000, as estimated by the FCC universal service model, known as the Hybrid Cost Proxy Model, and sometimes referred to as the Synthesis Model.[13]

The Synthesis Model is a bottom-up, engineering/economic model of modern telephone networks. It takes (geo-coded) customer locations and existing wire center locations as given and constructs (at least in theory) an optimized distribution network, including loops and other elements, to serve those customers. In doing so, the model chooses between analog, fiber, and HDSL technologies, again, theoretically at least, choosing the technology that is most efficient. It is generally agreed that variation in the costs of providing local telephone service is driven primarily by loop costs, which in turn are driven by population density, wire length and related geographic factors.[14] These factors are indeed taken into account by the Synthesis Model, which "constructs" a virtual network of loops in considerable detail, as the model is designed to link individual customers to wire centers in an optimal manner.

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[12] Indeed, the inability to actually observe forward-looking (as opposed to historical) costs is one of several arguments against the use of the TELRIC approach in the first instance.

[13] See Federal-State Joint Board on Universal Service, CC Docket 96-45, Ninth Report and Order and Eighteenth Order on Reconsideration, 14 FCC Rcd 20432, ¶40-41 (1999). The data report costs by wirecenter. Because the UNE rate data we rely upon is based only on RBOC wirecenters (see n. 9 above), we calculate the average UNE cost for each state based on those wirecenters that belong to the major RBOC in that state. The averages are weighted by the total number of lines in each wirecenter.

[14] See Jaison R. Abel and Vivian Witkind-Davis, "Geographic Deaveraging of Wholesale Prices for Local Telephone Service in the United States: Some Guidelines for State Commissions," National Regulatory Research Institute, NRRI 00-11, April 2000. "[T]he cost of the loop drives almost all of the variation that exists in providing local telephone service" (p. 5). "[A] substantial portion of the cost of the loop is determined by wire length and the geographic density of the customer locations served. (p. 6).

While not originally developed for UNE price regulation, the Synthesis Model is designed to estimate going-forward costs for individual UNE elements, and is thus conceptually consistent with the TELRIC approach. Furthermore, and perhaps most importantly for our purposes, the Synthesis Model is applied consistently across states. Thus, the underlying cost estimates that emerge from the model are – unlike the TELRIC rates set by state PUCs – unaffected by regulatory discretion.

The Synthesis Model (and similar models) is controversial when used to estimate the absolute level of costs. Parties disagree as to which costs and constraints are actually variable over the planning horizon, and over basic cost factors such as labor rates and pole costs.[15] For our purposes, however, these controversies are of little impact, as they do not concern comparisons of relative average costs across states.

The central results reported do not depend on whether the Synthesis Model estimate of UNE costs is correct in absolute magnitude. Instead, we argue that the FCC model provides magnitudes that accurately vary *in proportion* to true costs. By this we mean that, when comparing any pair of states, the state whose FCC UNE cost measure is 20% higher is a state where the true (unknown) costs are also 20% higher. Thus, we expect that our measure of state-average UNE costs accurately represents differences in average costs across states. This accuracy arises because the model is consistently applied to all states, and also because it gives particular attention to the cost factor of primary importance, the design of the loops, by focusing on individual wire centers in detail and then aggregating to the state level.

The FCC itself has used the model as the standard for measuring relative cost differences among states in its "benchmarking" procedure, sometimes referred to as the "TELRIC Test," for evaluating TELRIC rates in the context of Section 271 reviews. In

[15] See Timothy J. Tardiff, "Pricing Unbundled Network Elements and the FCC's TELRIC Rule: Economic and Modeling Issues," Review of Network Economics 1:2, September 2002, pp. 132-146.

this procedure, "Relative costs differences among states are determined by reference to the results of the Synthesis Model that the Commission uses for universal service purposes."[16] UNE rates for two states are expected to be in the same proportion as UNE costs for those two states as estimated by the FCC Synthesis Model. This comparison of proportionality obviates the need to determine the extent to which the Synthesis Model does or does not overstate true UNE costs. As the FCC put it, "We have previously noted that while the USF cost model should not be relied upon to set rates for UNEs, it accurately reflects the relative cost differences among states."[17] Our analysis, in essence, is a generalized form of the TELRIC Test, as the extent to which a state's rate deviates from the fitted value generated by a regression equals the deviation from a TELRIC benchmark, where the comparison is not to another actual state but rather to a composite of all states.[18] In sum, it is appropriate to rely on Synthesis Model costs as representative of cost differences across states.

To construct our measure of state-average UNE costs, we go to the most recent data made available by the FCC on its website, for the year 2000.[19] The data present a spectrum of variables indicating physical and cost attributes for each wire center, detailed to the point that cables and manholes are individually listed components of the calculation. We take the loop cost for each wire center and calculate a weighted

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[16] TELRIC NPRM, ¶28, n. 62.

[17] *Joint Application by SBC Communications, Inc. et al. for Provision of In-Region, InterLATA Services in Kansas and Oklahoma,* CC Docket No. 00-217, January 19, 2001, ¶84. (Hereafter, "SBC Order.")

[18] Strictly speaking, the TELRIC Test is equivalent in our context to a regression of UNE rates on FCC Costs, without an intercept term. Our regressions are in the spirit of a TELRIC Test, in that the method compares state differences in rates to differences in their costs, but has the advantage of being more general in the functional form, the mathematical relationship, between them.

[19] See http://www.fcc.gov/wcb/tapd/hcpm/welcome.html. While the Synthesis Model data are for 2000 and the UNE rate data are for 2003, we argue that the cost data are appropriately representative. First, there is no reason to believe that there have been sufficient changes in wire center locations and in customer locations to produce significant shifts in the relative positions of state-average UNE costs across states. Undoubtedly there are specific locations, around specific wire centers, where costs have shifted to a notable extent. But it is unlikely that these would significantly impact a state-average measure based on an average across a number of wire centers, given only three years of change. Second, any technological improvements in UNE provision since 2000 would be applied in the model across all states and wire centers. Thus, a more recent (and unavailable) version of the model might generate different outcomes, reflecting the improvements, but these there is no reason to believe these improvements would alter appreciably the *relative* UNE costs at the state-average level.

average loop cost for the state, where the weight given to each wire center's values is the total number of lines at that center. We construct those measures for 48 states and the District of Columbia to match the NRRI data on UNE rates.[20]

A graphical representation of the data (for loop rates) is contained in the scatter plot diagram in Figure One.[21] The vertical axis measures the actual loop rate set by the states, while the underlying cost is measured on the horizontal axis. Each point in the diagram represents a single state. Two characteristics of the data are immediately noticeable upon visual inspection.

First, all states have set UNE rates significantly below costs. The diagonal line represents unity between UNE rates and costs; thus, all states are represented by points below the diagonal line.[22] Second, as the haphazard scattering of the points suggests, there does not appear to be a consistent relationship between rates and costs. For example, a number of states have cost levels between $20 and $23, but these states have set rates that vary from $8 to $20 – i.e., a deviation from costs ranging from a low of $3 to a high of $12. This simple visual analysis conveys much of the intuition of what the data reveal. In order to rigorously support and expand upon this intuition, we analyze the data statistically using regression analysis.

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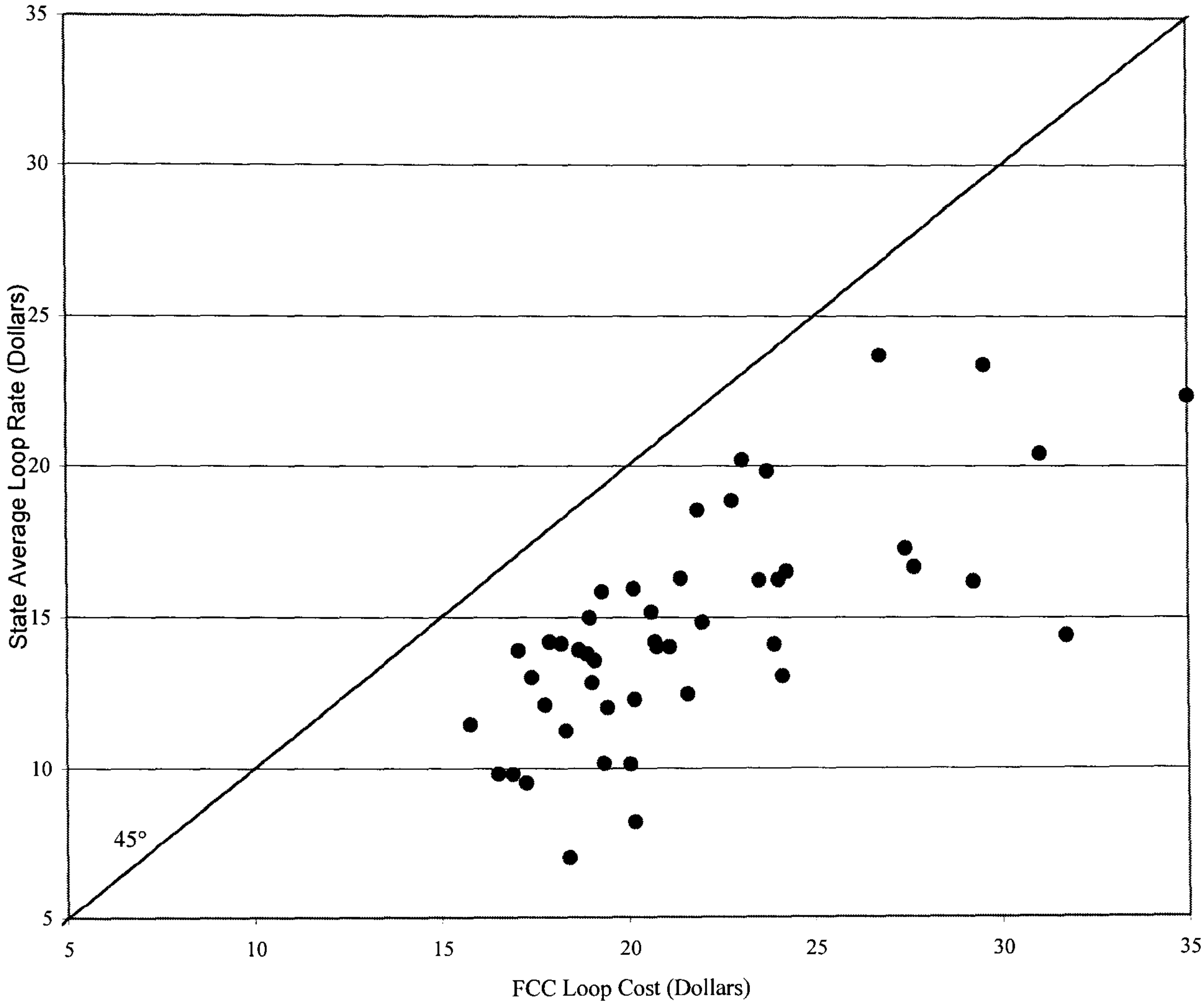
[20] NRRI reports rates but not state-average rates for Alaska and Hawaii.

[21] A complete data set is contained in the tables in Appendix One.

[22] There has been extensive debate over the level of UNE rates, in particular whether the TELRIC model results in rates that adequately compensate incumbents and/or create sufficient incentives for new investment. As noted above, the analysis here is not focused on the level of rates, but rather on their variability across states. A recent FCC White Paper discusses the potential for TELRIC to result in below-cost rates. See David M. Mandy and William W. Sharkey, "Dynamic Pricing and Investment from Static Proxy Models," FCC OSP Working Paper Series, #40 (September 2003). Available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-238934A2.doc.

**Figure One**
UNE Loop Rate vs. FCC Loop Cost
July 2003




Note: The point for DC is not shown.

## IV. Regression Analysis of Rate Variation Across States

To more formally measure the variability of UNE rates relative to costs, we utilize standard Ordinary Least Squares (OLS) regression analysis.

We specified three sets of regressions. First, we regress the state-average UNE rate on the corresponding UNE cost. Second, we regress the logarithmic value of the state-average UNE rate on the logarithmic value of the UNE cost estimate. The so-called log-log version of the regression allows the relationship between costs and rates to be proportional. Thus, the first regression evaluates what, on average, happens to a UNE rate when the estimated UNE cost increases by a dollar. The second regression, by comparison, evaluates how much, on average, a UNE rate changes in percentage terms when the estimated UNE cost increases by a percent. Third, we regressed the state-average UNE rate on the corresponding UNE cost, but weighted the observations according to the number of telephone lines in the state. We performed all three sets of regressions for both UNE loops and for the UNE-platform, and the results constitute the primary evidence we rely upon in making our conclusions.[23]

In most instances, regression analysis is utilized to estimate the influence of various "causal" factors (the "independent variables") on a variable of interest (the "dependent variable"). The influence of these factors is indicated by the sign, magnitude and statistical significance of the "estimated coefficients" on those variables, as calculated by the regression procedure.

In the case of a simple OLS regression, like the ones used here, the estimated coefficient can be thought of as reflecting the *average* impact of the independent variable on the dependent variable. Thus, in the first set of regressions referred to above, a coefficient of 1.0 on the UNE cost variable would mean that, for each $1

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[23] All of the specifications we estimated yielded similar results, and all are reported in Appendix Two. Throughout the text, we focus on the results of the un-weighted linear model for loop rates. As a careful examination of Appendix Two will show, these results are representative of those for the models as a group.

increase in UNE costs across the states, *on average* the UNE rates in those states were $1 higher as well – even though in some states, the rate might be $1.50 higher, and others only $0.50. The estimated coefficient indicates the average relationship, not the relationship for all states or any one particular state.

The tale of the average state is an inaccurate guide to the regulatory environment LECs face, however, as they must comply with the individual decisions made by each of the states. Thus, the coefficient on FCC Cost in the regressions, which represents the magnitude of the average relationship across the states, gives no indication whatsoever of the extent to which state PUC decisions individually deviate from a cost standard. In particular, many individual states can deviate considerably from a cost-based standard, some high, and some low, even if on average rates tend to increase with costs to some extent.

Regression analysis also yields an estimate of the extent to which individual observations deviate from the average, a measure of which is contained in the unexplained component of the variation in the variable of interest, i.e., the error terms, or "residuals," from the regression. When one regresses UNE rates on UNE costs, the unexplained component of the variation in UNE rates across states is that part of the variation that cannot be connected statistically to UNE costs.

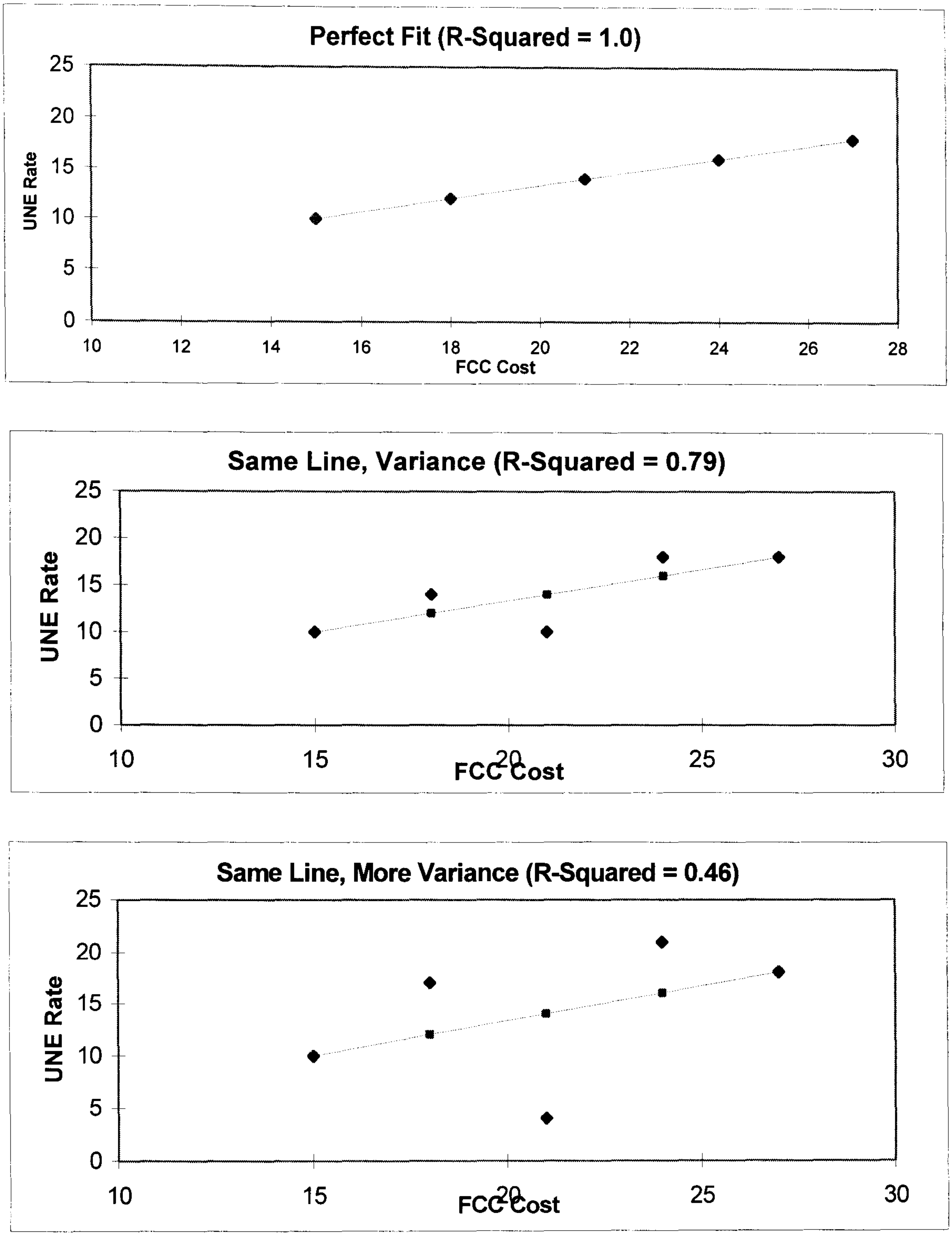
One output of an OLS regression is the so-called "fitted value" for each observation, i.e., the rate the model predicts would hold if each state set rates in response to the cost measures in the same way. If all states set UNE rates in the same proportion to UNE costs, then the regression of UNE rates on those costs would result in a perfect fit, and the fitted values would equal the actual rates.

The OLS method, in this case, acts to determine the rate-setting behavior of an average state, and the fitted values represent the rates that such an average state would choose when faced with the specific cost values in any particular state. The fitted value represents not the actual rate chosen by that state's PUC but instead a prediction of what a hypothetical PUC, representing the average behavior across all PUCs, would choose as the rate for each state, given that state's unique cost circumstances.

Thus, the OLS method establishes a benchmark for comparisons across states by estimating a forecast of a consistent UNE rate, based on costs. Examination of the extent to which actual UNE rates deviate from this standard, then, reveals the extent to which individual states fail to establish rates in a consistent manner, as required by the Act and mandated by the FCC's TELRIC Rules.

An illustration of the relationship between the coefficients and the residuals arising from our regression model appears in Figure Two, which shows three alternative results for five hypothetical states. In each case the left axis represents the average UNE rate for a state, while the bottom axis represents the measure of UNE costs. The line in the graph represents the fitted values – i.e., the relationship between the cost measure and the rate for the average state, as estimated by the regression procedure. Our hypothetical examples have been constructed such that the regression model estimates the same average fitted values for each set of data, such that the coefficient (the slope of the line) and the intercept are the same in all three examples. In the top diagram, the actual rates set by the states correspond perfectly to the cost measure. The residuals are zero as the points lie on the line. In the middle and bottom diagrams, however, three states have chosen rates that differ from the fitted values that the regression indicates should have been chosen. It is the magnitudes of these differences, these residuals, that are of interest here.

**FIGURE TWO**
Relationship Between Variance, Fit and R-Squared Statistic




## V. Regression Results

Our empirical results show that the residuals in our regressions, i.e., the variations in state-set UNE rates not explained by variations in costs, are substantial.

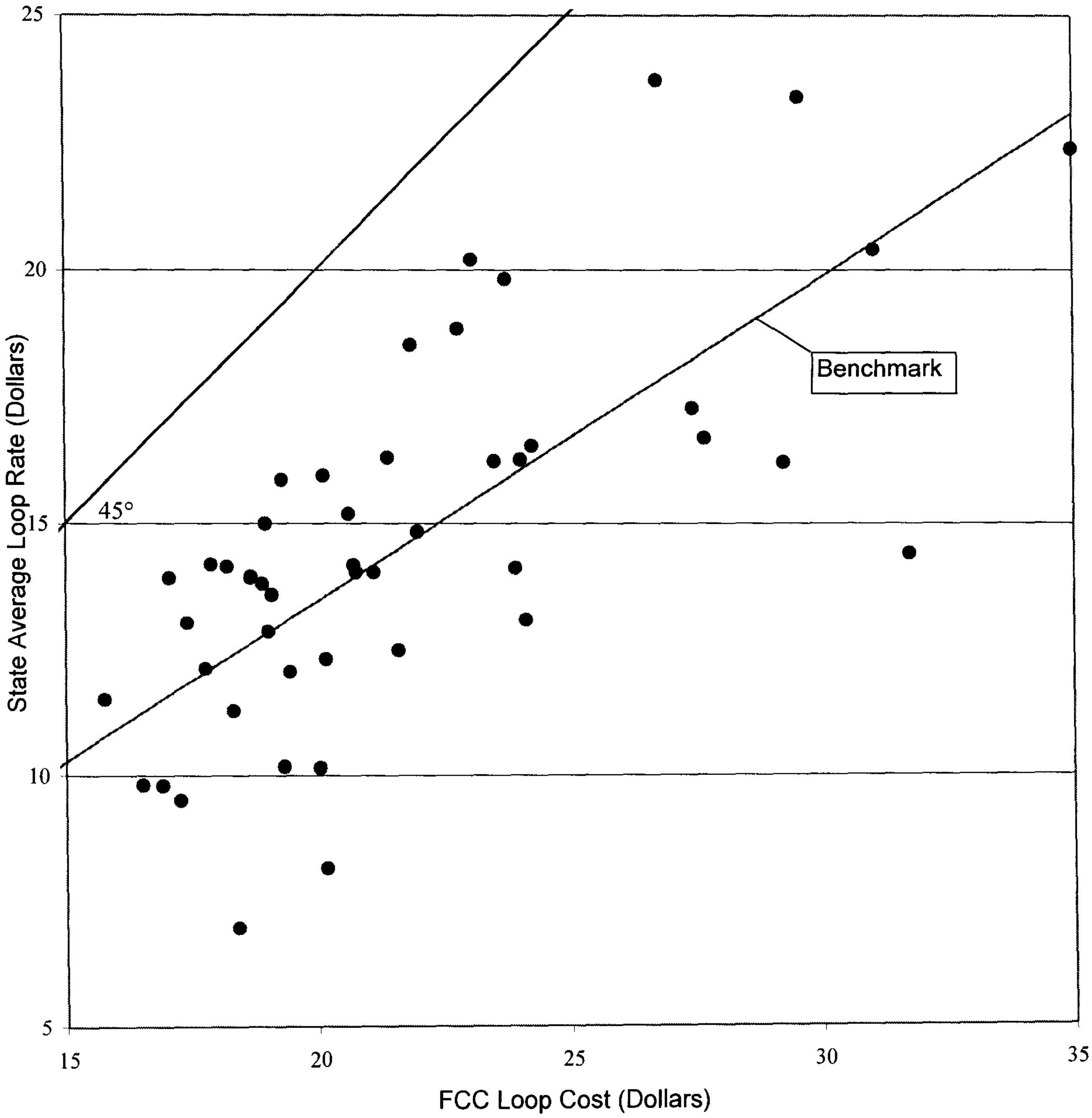
At the core of our inquiry is the question of whether the differences among states in UNE rates can be explained by underlying cost factors, as the Act and the TELRIC Rules require. In short, do costs explain rates, or are there other phenomena, such as regulatory error, or the pursuit of objectives outside the TELRIC framework, that explain the rates that emerge from the PUCs? In terms of our model, the question reduces to a simple one: When UNE rates are regressed on UNE costs, how much of the cross-state variation do UNE costs explain?

Figure Three replicates the scatter plot from Figure One, but this time with an added line showing the fitted values from our linear, unweighted regression of UNE rates on costs – i.e., the rates each state would set if all states set cost-based rates using a consistent formula. As discussed above, the fitted values are equivalent to the "benchmark" rates that would apply in the FCC's TELRIC Test, where the comparison is not to another actual state but rather to a composite of all states. [24]

The most common measure of explanatory power for a regression is the R-squared measure. Referring back to Figure Two above, note that a "perfect fit" regression analysis generates an R-squared statistic of 1.00, indicating that 100 percent of the variation is explained. As the actual values deviate more widely from the fitted

[24] Table One reports the actual UNE loop rates, the fitted values determined by the regression, and the deviation of the rate from the benchmark rate – i.e., the difference between the rate and the fitted value.

**Figure Three**
UNE Loop Rate vs. Benchmark
July 2003




Note: The point for DC is not shown.

values, the R-squared statistic declines accordingly. An R-squared of 0.46, as in the bottom chart in Figure Two, means that, of the variation across data points in the variable to be explained (here, the UNE rate), only 46% is connected to variation in the set of explanatory variables or, conversely, that 54% of the variation is unexplained.[25]

The R-squared statistics from our regression analyses are presented in Table One. The results are consistent across all specifications of the model: Only about one half of the variation in UNE rates can be explained by underlying costs. This outcome applies for regressions for loop rates, and UNE-P rates, for both linear and log-linear specifications.

**Table One**
Regression Results, R-Squared Statistics

| **Rate** | **Functional Form** | **Weight** | **$R^2$** |
|---|---|---|---|
| Loop | Linear | None | 0.53 |
| | | Total Lines | 0.48 |
| | Log-Log | None | 0.52 |
| | | Total Lines | 0.52 |
| UNE-P | Linear | None | 0.55 |
| | | Total Lines | 0.44 |
| | Log-Log | None | 0.54 |
| | | Total Lines | 0.53 |

The four regressions (weighted and unweighted, linear and log-log) of UNE loop rates on FCC costs show R-squared values of 0.53, 0.48, 0.52 and 0.52. Thus, about one half of the variation in UNE loop rates can be explained by variations in costs. For

25 In some contexts the extent to which the variation can be explained is unknown – thus, it is difficult to say whether the explanatory variables fully determine the variable to be explained. In the case of UNE rate setting, however, there is a standard, as both the Act and the FCC dictate that rates are to be based on costs. Thus, an R-squared value less than 0.50 in a regression of UNE rates on UNE costs means that over half of the variation in UNE rates is unrelated to variation in costs as represented by the Synthesis Model. This is true even though we are using a cost measure whose absolute magnitudes are in dispute.

UNE-P, the four R-squared values are 0.55, 0.44, 0.54 and 0.53. Again, about one half of UNE-P rate variation is due to factors other than costs.

As shown in Table Two, a simple tally of the extent of the deviations further illustrates this point. Over half of the states have chosen a rate deviating from the benchmark rate by at least 10%. Up to one-fourth deviate by more than 20%, and a number of states deviate by more than 30% from the benchmark rate.

More formal measures of deviation tell the same story. The *root mean squared error* (RMSE) of a regression is a measure of the average extent to which the dependent variable deviates from levels that would be expected if it were determined only by the variables included in the regression model.[26] It has the additional advantage that the OLS regression technique is designed to generate a set of coefficient estimates and residuals that minimizes its value. Thus, the technique searches for an outcome where as much of the variation in UNE rates is explained as possible with the given set of explanatory variables. If those explanatory variables properly represent variations in costs across states, then the remaining, unexplained variation must not be linked to costs in any way.

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[26] The RMSE is the square root of the mean squared error, where the latter is the sum of the squared residuals, divided by the number of residuals. Other measures that can be used to summarize the extent of variation include the mean absolute error (the average deviation away from the "fitted value" for each state in the regression, where absolute values are taken so that positive and negative deviations do not cancel out) and median absolute error (the median deviation).

**Table Two**
Measures of Statistical Variation in UNE Regressions

| Model | Loop Linear | Loop Linear Weighted | UNE-P Linear | UNE-P Linear Weighted |
|---|---|---|---|---|
| **Statistical Measures of Residuals** | | | | |
| Mean Rate | $14.44 | $12.48 | $17.64 | $15.60 |
| Mean Absolute Error | $2.07 | $2.14 | $2.17 | $2.25 |
| Median Absolute Error | $1.71 | $1.64 | $1.97 | $1.90 |
| Root Mean Square Error | $2.73 | $2.08 | $2.73 | $2.37 |
| RMSE as % of Mean Rate | 19% | 17% | 15% | 15% |
| Maximum Residual | $6.56 | $6.41 | $6.84 | $6.49 |
| **States Where Actual Rate Deviates From Fitted Rate By...** | | | | |
| >10% | 29 | 30 | 27 | 31 |
| >20% | 13 | 16 | 8 | 7 |
| >30% | 6 | 5 | 2 | 2 |

In our regressions, the RMSE measures are quite large. Referring again to Table Two, note that, for UNE loops, the average unweighted UNE rate in July 2003 was $14.44, and the RMSE was $2.73. Thus, the average deviation, as measured by RMSE, of UNE rates from benchmark rates in this case is 19% of the average rate itself.[27]

A final perspective on UNE rate variation is provided by examining variation in rates for states that have similar benchmark rates as estimated by the regression. For example, the linear specification of the loop rate model yields benchmark rates between $14 and $16 for 10 states. Of these, only three states have actual rates between $14

[27] These percentages are simply the RMSE divided by the average rate. As shown in the table, the comparable figure for the UNE-P regression is 15%. Other measures of typical deviation include the mean absolute error and the median absolute error, which are also reported in Table Two.

and $16, and actual rates range from a low of $12.49 to a high of $20.21 – a range of $7.72.[28] Such variation would not appear to meet the FCC's goal of "consistent and predictable" rates based solely on costs.

However measured, then, it is clear that UNE rates as set by the states do not bear a consistent or predictable relationship to costs as measured by the Synthesis Model. Moreover, the deviations of rates from what a consistent model would require are substantial, averaging 15-19% percent, and often exceeding 30%.

Implications and Conclusions

Price deviations of the magnitude reported here can be expected to have real and substantial economic effects. It is notable, for example, that the Department of Justice, in its guidelines for merger analysis, has established a benchmark of 5% as an economically significant variation of prices from the competitive level.[29]

More to the point, perhaps, the FCC has itself determined that deviations of UNE rates of such magnitudes are problematic. In its SBC Kansas/Oklahoma 271 Order, for example, the Commission compared SBC's weighted average loop rates for the Oklahoma study area ($18.87) with those in Texas ($14.10), a difference of 33.8%. The FCC found that the Synthesis Model measure of Oklahoma's loop costs was 23% higher than for Texas. Applying the TELRIC test, the Commission used this figure to produce an adjusted benchmark loop rate for Texas of $17.34 ($14.10 times 1.23), leaving a gap $1.53 ($18.87 minus $17.34), or 8.8%. The Commission's Order concluded such a deviation from the benchmark rate was "not *de minimus*," and

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[28] The earlier comparison considered actual rates for states with similar cost levels instead of similar predicted rates.

[29] Strictly speaking, the 5% threshold is used at an intermediate point in the evaluation (in determining the "relevant market") as final consideration of merger effects is done indirectly. Horizontal Merger Guidelines, United States Department of Justice and the Federal Trade Commission, revised April 8, 1997, Section 1.11. Available at http://www.usdoj.gov/atr/public/guidelines/horiz_book/hmg1.html.

determined that it could not "ignore its presence."[30] Our results show that more than half the states have set UNE rates that deviate from the benchmark by more than 8.8%.

The primary consequences of such scatter-shot prices are uncertainty and misallocation of resources.

Uncertainty arises out of the fact that UNE rates must be continually revised to reflect changes in underlying cost factors.[31] It is clear that states set rates in response to a variety of factors other than costs. Because these rates cannot be predicted by reference to a basic principle such as that stated by the FCC, businesses cannot expect them to remain stable. Business planning is adversely affected by this uncertainty, especially in an environment in which decisions about capital allocation, entry or exit from markets, etc., involve significant sunk costs and thus have long-run consequences for incumbents and non-incumbents alike.

A second economic consequence relates to allocative efficiency. Even if UNE rates reflected the economically efficient level on average, deviation among states would still result in misallocation of resources. ILECs will choose to over-invest (relative to the economically efficient level) in states with UNE rates that are relatively high as compared to costs, as will CLECs looking for alternatives to purchasing UNEs. States with low UNE rates will, by comparison, suffer underinvestment in their telecom infrastructures.

To summarize our results, we compare UNE rates as set by the states with benchmark rates based on the FCC's Synthesis Model. We find that UNE rates do not bear a consistent relationship to underlying costs. These findings confirm the FCC's concerns, as expressed the TELRIC NPRM, that observed variation in UNE rates, rather than reflecting underlying costs, "may be the product of the complexity of the issues, the very general nature of our rules, and uncertainty about how to apply those

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[30] SBC Order, ¶83-85. Ultimately the FCC decided that, since SBC was offering promotional, discounted loop rates that were less than $17.34, those rates were appropriate for 271 compliance.
[31] See TELRIC NPRM, ¶138-140.

rules." The Commission is correct to conclude that "the resulting rates might not, therefore, achieve fully the Commission's goal of sending appropriate economic signals."[32]

[32] TELRIC NPRM, ¶6

**Appendix One**
Cost and Rate Data

| State | Loop Cost | Loop Rate | | | | |
|---|---|---|---|---|---|---|
| | | Jul-01 | Jan-02 | Jul-02 | Jan-03 | Jul-03 |
| AL | 27.67 | 19.04 | 19.04 | 19.04 | 16.66 | 16.66 |
| AR | 24.13 | . | 13.09 | 13.09 | 13.09 | 13.09 |
| AZ | 17.77 | 21.98 | 21.98 | 21.98 | 12.12 | 12.12 |
| CA | 16.51 | . | 11.70 | 9.93 | 9.93 | 9.82 |
| CO | 19.29 | . | 20.65 | 15.85 | 15.85 | 15.85 |
| CT | 21.60 | 12.49 | 12.49 | 12.49 | 12.49 | 12.49 |
| DC | 13.17 | 10.81 | 10.81 | 10.81 | 4.29 | 4.29 |
| DE | 19.45 | 12.05 | 12.05 | 12.05 | 12.05 | 12.05 |
| FL | 18.68 | . | 15.81 | 15.81 | 13.95 | 13.95 |
| GA | 20.17 | 16.51 | 16.51 | 16.51 | 12.55 | 12.30 |
| IA | 20.14 | 20.15 | 20.15 | 16.47 | 15.94 | 15.94 |
| ID | 23.07 | 25.52 | 25.52 | 20.42 | 20.21 | 20.21 |
| IL | 16.90 | 9.81 | 9.81 | 9.81 | 9.81 | 9.81 |
| IN | 20.17 | 8.20 | 8.20 | 8.20 | 8.20 | 8.20 |
| KS | 20.77 | 14.04 | 14.04 | 14.04 | 14.04 | 14.04 |
| KY | 27.43 | 19.65 | 20.00 | 18.41 | 17.26 | 17.26 |
| LA | 24.03 | . | 17.31 | 17.31 | 16.24 | 16.24 |
| MA | 17.06 | 14.98 | 14.98 | 14.98 | 14.98 | 13.93 |
| MD | 18.32 | 14.50 | 14.50 | 14.50 | 12.00 | 11.26 |
| ME | 29.25 | 17.53 | 17.53 | 16.19 | 16.19 | 16.19 |
| MI | 20.04 | 10.15 | 10.15 | 10.15 | 10.15 | 10.15 |
| MN | 19.02 | 17.87 | 17.87 | 17.87 | 17.87 | 12.86 |
| MO | 20.63 | . | 15.19 | 15.19 | 15.19 | 15.19 |
| MS | 34.99 | . | 21.26 | 21.26 | 22.37 | 22.37 |
| MT | 26.76 | 27.41 | 27.41 | 23.72 | 23.72 | 23.72 |
| NC | 20.71 | 16.71 | 15.88 | 15.88 | 14.18 | 14.18 |
| ND | 21.41 | . | 19.75 | 17.79 | 16.28 | 16.28 |
| NE | 21.12 | 14.32 | 15.79 | 17.51 | 14.04 | 14.04 |
| NH | 23.52 | 17.99 | 17.99 | 17.99 | 16.21 | 16.21 |
| NJ | 17.26 | 16.17 | 9.52 | 9.52 | 9.52 | 9.52 |
| NM | 21.87 | . | 20.50 | 20.50 | 18.52 | 18.52 |
| NV | 23.75 | 19.83 | 19.83 | 19.83 | 19.83 | 19.83 |
| NY | 15.77 | 14.81 | 14.81 | 11.49 | 11.49 | 11.49 |
| OH | 18.40 | . | 7.01 | 7.01 | 7.01 | 7.01 |
| OK | 21.99 | 14.84 | 14.84 | 14.84 | 14.84 | 14.84 |

| State | Loop Cost | Loop Rate | | | | |
|---|---|---|---|---|---|---|
| | | Jul-01 | Jan-02 | Jul-02 | Jan-03 | Jul-03 |
| OR | 18.96 | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 |
| PA | 18.90 | 13.81 | 13.81 | 13.81 | 13.81 | 13.81 |
| RI | 18.67 | . | 13.93 | 13.93 | 13.93 | 13.93 |
| SC | 24.25 | . | 17.60 | 17.60 | 16.51 | 16.51 |
| SD | 22.80 | . | 21.09 | 21.09 | 21.09 | 18.84 |
| TN | 23.92 | 14.92 | 14.92 | 14.92 | 14.12 | 14.12 |
| TX | 18.20 | 14.15 | 14.15 | 14.15 | 14.15 | 14.15 |
| UT | 17.41 | 20.00 | 16.46 | 16.13 | 13.03 | 13.03 |
| VA | 19.10 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 |
| VT | 31.73 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 |
| WA | 17.88 | 11.33 | 18.16 | 14.56 | 14.20 | 14.20 |
| WI | 19.33 | 10.90 | 10.90 | 10.90 | 10.90 | 10.18 |
| WV | 31.04 | 24.58 | 24.58 | 24.58 | 20.41 | 20.41 |
| WY | 29.54 | . | 25.65 | 23.39 | 23.39 | 23.39 |

Source: See text.

## Appendix Two
Regression Results

| Model: Loop, Linear |
|---|

| | | | |
|---|---|---|---|
| **Dependent Mean** | 14.4386 | **R-Square** | 0.5316 |
| **Coeff Var** | 18.8866 | **Adj R-Sq** | 0.5216 |

| Parameter Estimates | | | | | |
|---|---|---|---|---|---|
| **Variable** | **DF** | **Parameter Estimate** | **Standard Error** | **t Value** | **Pr > \|t\|** |
| **Intercept** | 1 | 0.66745 | 1.9254 | 0.35 | 0.7304 |
| **LoopCost** | 1 | 0.63989 | 0.08761 | 7.3 | <.0001 |

| Model: Loop, Linear, Weighted |
|---|

| | | | |
|---|---|---|---|
| **Dependent Mean** | 12.481 | **R-Square** | 0.4771 |
| **Coeff Var** | 31976 | **Adj R-Sq** | 0.466 |

| Parameter Estimates | | | | | |
|---|---|---|---|---|---|
| **Variable** | **DF** | **Parameter Estimate** | **Standard Error** | **t Value** | **Pr > \|t\|** |
| **Intercept** | 1 | 0.67769 | 1.82781 | 0.37 | 0.7125 |
| **LoopCost** | 1 | 0.62182 | 0.09496 | 6.55 | <.0001 |

## Model: Loop, Log-Log

| | | | |
|---|---|---|---|
| Dependent Mean | 2.62849 | R-Square | 0.5221 |
| Coeff Var | 8.14187 | Adj R-Sq | 0.5119 |

| Parameter Estimates | | | | | |
|---|---|---|---|---|---|
| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
| Intercept | 1 | -0.79414 | 0.47861 | -1.66 | 0.1037 |
| LLoopCost | 1 | 1.12241 | 0.15663 | 7.17 | <.0001 |

## Model: Loop, Log-Log, Weighted

| | | | |
|---|---|---|---|
| Dependent Mean | 2.61787 | R-Square | 0.5186 |
| Coeff Var | 30.9766 | Adj R-Sq | 0.5084 |

| Parameter Estimates | | | | | |
|---|---|---|---|---|---|
| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
| Intercept | 1 | -0.78528 | 0.47923 | -1.64 | 0.108 |
| LLoopCost | 1 | 1.1191 | 0.15728 | 7.12 | <.0001 |

| Model: UNE-P, Linear |
|---|

| | | | |
|---|---|---|---|
| Dependent Mean | 17.6418 | R-Square | 0.5489 |
| Coeff Var | 15.4733 | Adj R-Sq | 0.5393 |

| Parameter Estimates | | | | | |
|---|---|---|---|---|---|
| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
| Intercept | 1 | 2.9023 | 1.98755 | 1.46 | 0.1509 |
| LoopPortCost | 1 | 0.65893 | 0.08713 | 7.56 | <.0001 |

| Model: UNE-P, Linear, Weighted |
|---|

| | | | |
|---|---|---|---|
| Dependent Mean | 15.5987 | R-Square | 0.441 |
| Coeff Var | 29196 | Adj R-Sq | 0.4291 |

| Parameter Estimates | | | | | |
|---|---|---|---|---|---|
| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
| Intercept | 1 | 2.56315 | 2.16868 | 1.18 | 0.2432 |
| LoopPortCost | 1 | 0.65789 | 0.10805 | 6.09 | <.0001 |

| Model: UNE-P, Log-Log |
|---|

| | | | |
|---|---|---|---|
| Dependent Mean | 2.84038 | R-Square | 0.5347 |
| Coeff Var | 6.37707 | Adj R-Sq | 0.5248 |

| Parameter Estimates | | | | | |
|---|---|---|---|---|---|
| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
| Intercept | 1 | -0.2737 | 0.42456 | -0.64 | 0.5223 |
| LLoopPortCost | 1 | 1.00804 | 0.13717 | 7.35 | <.0001 |

| Model: UNE-P, Log-Log, Weighted |
|---|

| | | | |
|---|---|---|---|
| Dependent Mean | 2.83161 | R-Square | 0.5302 |
| Coeff Var | 24.24611 | Adj R-Sq | 0.5202 |

| Parameter Estimates | | | | | |
|---|---|---|---|---|---|
| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
| Intercept | 1 | -0.26020 | 0.42533 | -0.61 | 0.5436 |
| LoopPortCost | 1 | 1.00348 | 0.13779 | 7.28 | <.0001 |

## Appendix Three

UNE Loop Residuals by State

| State | FCC Loop Cost | Loop Rate | Benchmark Loop Rate | Residual | Total Lines |
|---|---|---|---|---|---|
| AL | 27.67 | 16.66 | 18.37 | -1.71 | 2,163,753 |
| AR | 24.13 | 13.09 | 16.11 | -3.02 | 1,218,051 |
| AZ | 17.77 | 12.12 | 12.04 | 0.08 | 3,560,396 |
| CA | 16.51 | 9.82 | 11.23 | -1.41 | 23,176,232 |
| CO | 19.29 | 15.85 | 13.01 | 2.84 | 3,863,694 |
| CT | 21.60 | 12.49 | 14.49 | -2.00 | 2,308,321 |
| DC | 13.17 | 4.29 | 9.09 | -4.80 | 1,245,866 |
| DE | 19.45 | 12.05 | 13.11 | -1.06 | 634,339 |
| FL | 18.68 | 13.95 | 12.62 | 1.33 | 7,541,990 |
| GA | 20.17 | 12.30 | 13.57 | -1.27 | 5,323,228 |
| IA | 20.14 | 15.94 | 13.55 | 2.39 | 1,544,254 |
| ID | 23.07 | 20.21 | 15.43 | 4.78 | 673,603 |
| IL | 16.90 | 9.81 | 11.48 | -1.67 | 8,617,424 |
| IN | 20.17 | 8.20 | 13.57 | -5.37 | 2,623,316 |
| KS | 20.77 | 14.04 | 13.96 | 0.08 | 1,739,364 |
| KY | 27.43 | 17.26 | 18.22 | -0.96 | 1,348,435 |
| LA | 24.03 | 16.24 | 16.04 | 0.20 | 2,573,557 |
| MA | 17.06 | 13.93 | 11.58 | 2.35 | 5,617,072 |
| MD | 18.32 | 11.26 | 12.39 | -1.13 | 4,166,080 |
| ME | 29.25 | 16.19 | 19.38 | -3.19 | 747,812 |
| MI | 20.04 | 10.15 | 13.49 | -3.34 | 6,328,292 |
| MN | 19.02 | 12.86 | 12.84 | 0.02 | 3,160,775 |
| MO | 20.63 | 15.19 | 13.87 | 1.32 | 3,200,508 |
| MS | 34.99 | 22.37 | 23.06 | -0.69 | 1,407,426 |
| MT | 26.76 | 23.72 | 17.79 | 5.93 | 459,895 |
| NC | 20.71 | 14.18 | 13.92 | 0.26 | 3,035,562 |
| ND | 21.41 | 16.28 | 14.36 | 1.92 | 381,967 |
| NE | 21.12 | 14.04 | 14.18 | -0.14 | 831,875 |
| NH | 23.52 | 16.21 | 15.71 | 0.50 | 916,987 |
| NJ | 17.26 | 9.52 | 11.71 | -2.19 | 7,288,011 |
| NM | 21.87 | 18.52 | 14.66 | 3.86 | 1,012,869 |
| NV | 23.75 | 19.83 | 15.86 | 3.97 | 387,113 |
| NY | 15.77 | 11.49 | 10.76 | 0.73 | 16,655,431 |
| OH | 18.40 | 7.01 | 12.44 | -5.43 | 5,024,596 |
| OK | 21.99 | 14.84 | 14.74 | 0.10 | 1,957,569 |

| State | FCC Loop | Loop | Benchmark | Residual | Total |
|---|---|---|---|---|---|

| | Cost | Rate | Loop Rate | | Lines |
|---|---|---|---|---|---|
| OR | 18.96 | 15.00 | 12.80 | 2.20 | 1,970,847 |
| PA | 18.90 | 13.81 | 12.76 | 1.05 | 6,983,626 |
| RI | 18.67 | 13.93 | 12.62 | 1.31 | 754,654 |
| SC | 24.25 | 16.51 | 16.19 | 0.32 | 1,624,947 |
| SD | 22.80 | 18.84 | 15.25 | 3.59 | 399,234 |
| TN | 23.92 | 14.12 | 15.97 | -1.85 | 3,147,495 |
| TX | 18.20 | 14.15 | 12.31 | 1.84 | 11,991,509 |
| UT | 17.41 | 13.03 | 11.81 | 1.22 | 1,634,449 |
| VA | 19.10 | 13.60 | 12.89 | 0.71 | 4,102,152 |
| VT | 31.73 | 14.41 | 20.97 | -6.56 | 350,325 |
| WA | 17.88 | 14.20 | 12.11 | 2.09 | 3,415,438 |
| WI | 19.33 | 10.18 | 13.04 | -2.86 | 2,627,604 |
| WV | 31.04 | 20.41 | 20.53 | -0.12 | 896,455 |
| WY | 29.54 | 23.39 | 19.57 | 3.82 | 304,301 |

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